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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/642,797

08/18/2003

Georgiy Buyanovskiy

11382-003-999

3685

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7590

09/09/2005

MORGAN LEWIS & BOCKIUS LLP
1111 PENNSYLVANIA AVENUE NW
WASHINGTON, DC 20004

EXAMINER

PAPPAS, PETER

ART UNIT

PAPER NUMBER

2671

DATE MAILED: 09/09/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/642,797

Applicant(s)

BUYANOVSKIY, GEORGIY

Examiner

Peter-Anthony Pappas

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 18 August 2003.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-68 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-6, 20-26, 40-46, 60 and 61 is/are rejected.
- 7) ☒ Claim(s) 7-19, 27-39 and 47-59 is/are objected to.
- 8) ☒ Claim(s) 1-68 are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____
- 4) ☒ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

Election/Restrictions

1. Restriction to one of the following inventions is required under 35 U.S.C. 121:
 - I. Claims 1-61, drawn to adaptive direct volume rendering, classified in class 345, subclass 419.
 - II. Claim 62, drawn to estimating an amount of ray energy in a predefined reflection direction, classified in class 345, subclass 426.
 - III. Claims 63-64, drawn to determining the monotonicity of a function, classified in class 345, subclass 581.
 - IV. Claim 65, drawn to a data structure for representing an image volume, classified in class 707, subclass 100.
 - V. Claims 66-68, drawn to a direct volume rendering system comprising a plurality of processors, classified in class 345, subclass 502.
2. The inventions are distinct, each from the other because of the following reasons:

Inventions I, II, III, IV and V are related as combination and subcombination. Inventions in this relationship are distinct if it can be shown that the combination as claimed does not require the particulars of the subcombination as claimed for patentability and that the subcombination has utility by itself or in other combinations (MPEP § 806.05(c)). In the instant case the combination as claimed does not require the particulars of the subcombination as claimed and the subcombinations directed towards (II) estimating an amount of ray energy in a predefined reflection direction, (III) determining the monotonicity of a function, (IV) a data structure for representing an

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image volume and (V) a direct volume rendering system comprising a plurality of processors have separate utility by themselves.

3. Because these inventions are distinct for the reasons given above and the search required for Group I is not required for Groups II-V, restriction for examination purposes as indicated is proper.

4. During a telephone conversation with Francis E. Morris on 8/18 a provisional election was made with traverse to prosecute the invention of group I, claims 1-61. Affirmation of this election must be made by applicant in replying to this Office action. Claims 62-68 are withdrawn from further consideration by the examiner, 37 CFR 1.142(b), as being drawn to a non-elected invention.

Allowable Subject Matter

5. Claims 7-19, 27-39 and 47-59 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Claim Rejections - 35 USC § 102

6. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

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7. Claims 1-4, 20, 40-44 and 60-61 are rejected under 35 U.S.C. 102(e) as being unpatentable over Kaufman et al. (U.S. Pub. No. US 2004/0125103 A1).

8. In regards to claim 1 Kaufman et al. teaches a method and apparatus for real-time volume processing and universal 3D rendering (Abstract). Kaufman et al. teaches that a volumetric dataset is commonly represented as a 3D grid of volume elements (voxels) which is often stored as a full 3D raster (i.e., volume buffer) of voxels (p. 1, ¶ 8). Kaufman et al. teaches storing a set of data value parameters for each voxel (p. 3, ¶ 27, lines 7-8; p. 4, ¶ 30).

Kaufman et al. illustrates in Fig. 74 fragmenting said 3D grid of voxels into a plurality of sub-volumes of different sizes (p. 49-50, ¶ 569). It is noted said voxels are considered to contain data of said 3D scalar field.

Kaufman et al. illustrating in Fig. 44 casting a plurality of rays from a 2D projection plane 324 towards a sampled dataset (p. 34, ¶ 408). Kaufman et al. further teaches that rays comprises a ray energy (p. 40, ¶ 468). It is noted said rays comprising a ray energy are considered to have, at one point, an initial ray energy. It is inherent that a ray comprising energy has a cross section.

Kaufman et al. teaches that for directional light sources a single sweep along one major axis is sufficient to propagate the light energy to all the voxels. It is noted said voxels are considered to include a subset of the plurality of sub-volumes. For point light sources both inside and outside the volume, the light intensity is back-projected outward from the light source (illumination model) to every voxel using a slice-based approach (p. 44, ¶ 509). A transfer function converts each sample volume density into an opacity

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and color (p. 44, ¶ 510; Fig. 56 B, specifically element 552). It is noted said opacity transfer function is considered to contain data of said 3D scalar field. The multiplication of color and intensity yields a pixel color for each sample which is used in the compositing unit 60 to composite such color with the previously accumulated pixels along each sight ray (p.8, ¶ 132).

Kaufman et al. teaches estimating pixel values via interpolation at other location other 2D image plane using the pixel values at the selected locations (p. 34, ¶ 408).

9. In regards to claim 2 Kaufman et al. teaches fragmenting the 3D data set into 8 sub-volumes and for each sub-volume recursively fragmenting it into 8 smaller sub-volumes until the size of the smallest sub-volume reaches a predefined size limit (p. 49-50, ¶ 569; Fig. 74).

10. In regards to claim 3 Kaufman et al. teaches that in the recursive blocking method, the 3D volume data is recursively subdivided into preferably 8 octant blocks until the second lowest level it reaches is 2^3 (2x2x2) voxel blocks and finally a single voxel (p. 49-50, ¶ 569). Kaufman et al. further teaches that each voxel is scalar-valued (p. 30, ¶ 361, lines 2). It is noted that because each voxel is scalar-valued each corner of a given voxel is considered scalar-valued.

11. In regards to claim 4 Kaufman et al. teaches to trilinearly sample (i.e., perform a linear interpolation in 3D) the first ray, eight neighboring voxels are used (p. 39, ¶ 461). It is noted that for a given cell for which said ray is being determined the 8 corners of said cell are also a part of said 8 neighboring voxels.

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12. In regards to claim 20 Kaufman et al. teaches selecting a pixel, selecting four surrounding pixels for said pixel and performing bi-linear interpolation with the selected pixel data (p. 12, ¶ 170, lines 1-3). It is noted said pixels are located on a given projection plane and are considered the origins of respective rays.

13. In regards to claim 40 the rationale disclosed in the rejection of claim 20 is incorporated herein.

14. In regards to claim 41 Kaufman et al. teaches a application programming interface (API) for use by applications (p. 51, ¶ 580). It is inherent that said API and applications which access said API would be stored on a computer readable storage medium. The rationale disclosed in the rejection of claim 1 is incorporated herein.

15. In regards to claim 42 the rationale disclosed in the rejection of claim 2 is incorporated herein.

16. In regards to claim 43 the rationale disclosed in the rejection of claim 3 is incorporated herein.

17. In regards to claim 44 the rationale disclosed in the rejection of claim 4 is incorporated herein.

18. In regards to claim 60 the rationale disclosed in the rejection of claim 20 is incorporated herein.

19. In regards to claim 61 the rationale disclosed in the rejection of claim 1 is incorporated herein.

Claim Rejections - 35 USC § 103

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20. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

21. Claims 5, 25 and 45 are rejected under 35 U.S.C. 10a(a) as being unpatentable over Kaufman et al. (U.S. Pub. No. US 2004/0125103 A1), as applied to claims 1-4, 20, 40-44 and 60-61, in view of Ramanujam (U.S. Patent No. 5, 454, 068).

22. In regards to claim 5 Kaufman et al. fails to explicitly teach wherein the set of parameters include a maximum, average and minimum data value of the scalar field. Ramanujam teaches a 3D scientific visualization system for viewing models composed of polyhedra or other elements having vertices at which analysis results (e.g., temperature or pressure) are defined (Abstract). Ramanujam teaches that various ways of defining the zones (sub-volumes) and assigning elements of the model to zones are contemplated. One method is to define the zone sizes independently of the model, each zone encompassing a predetermined range of positions along the cutting plane normal or values of a given result, wherein each element is then assigned to a single zone, based upon a suitable vertex statistic such as the average of the maximum and minimum Z coordinates of the element vertices (column 2, lines 30-48).

It would have been obvious to one skilled in the art, at the time of the applicant's invention, to incorporate the teachings of Ramanujam into the system taught by Kaufman et al., because through such incorporation it would limit the search for

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elements intersected by the cutting plane thus allowing for data to be more efficiently accessed from a given zone (column 2, lines 49-62).

23. Claims 6, 26 and 46 are rejected under 35 U.S.C. 10a(a) as being unpatentable over Kaufman et al. (U.S. Pub. No. US 2004/0125103 A1), as applied to claims 1-4, 20, 40-44 and 60-61, in view of Lathrop (U.S. Patent No. 6, 597, 359 B1).

24. In regards to claim 6 Kaufman et al. fails to explicitly teach the use of an octree. Lathrop teaches an apparatus that performs the hierarchical space subdivision technique of accelerating a ray tracer, which can also be done dynamically. A preferred embodiment is a fully recursive and dynamic system employing an octree hierarchy (column 4, lines 2-6). Lathrop illustrates in Fig. 9 an octree comprised of a root node 20, a plurality of intermediate nodes 22 and 24, and a plurality of leaf nodes 21, 23, 25, 31 and 32. Lathrop teaches that the root node represents the entire scene volume, that the intermediate nodes represent a sub-volume that is larger than the smallest sub-volumes and that the leaf nodes represent the smallest sub-volumes (column 7, lines 18-32). It is noted said apparatus is considered to perform the method.

It would have been obvious to one skilled in the art, at the time of the applicant's invention, to incorporate the teachings of Lathrop into the method taught by Kaufman et al., because Kaufman et al. is directed towards the use of ray tracing and Lathrop provides a means by which to perform the hierarchical space subdivision technique of accelerating a ray tracer, thus allowing for more information to be processed within a given time frame.

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25. In regards to claim 26 the rationale disclosed in the rejection of claim 6 is incorporated herein.

26. In regards to claim 46 the rationale disclosed in the rejection of claim 6 is incorporated herein.

27. Claims 21-24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kaufman et al. (U.S. Pub. No. US 2004/0125103 A1), as applied to claims 1-4, 20, 40-44 and 60-61.

28. In regards to claim 21 Kaufman et al. teaches that a second component of board 616 is a set of hardware pipelines 604 called block processors (central processing units) as shown in Fig. 64 (p. 41, ¶ 478-480). It is noted said processors are considered to execute instructions. The rationale disclosed in the rejection of claim 1 is incorporated herein.

Kaufman et al. teaches that the apparatus and methods of the present invention, coupled with a geometry engine, combine volumetric and geometric approaches, allowing users to efficiently model and render complex scenes containing traditional geometric primitives (¶ 19), define a given image plane (¶ 126) and set the base sampling rate for the desired image quality (¶ 284). However, Kaufman et al. fails to explicitly teach a user interface for receiving said user specified information. Official Notice is take that both the concept and advantages of providing a user interface for a given rendering system so to allow a given operator to control said system is well known and expected in the art. Thus, it would have been obvious to one skilled in the art, at the time of the applicant's invention, to incorporate a user interface into the system

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taught by Kaufman et al., because through such incorporation it would provide a conventional and simple means of user input for the control of said graphics system.

29. In regards to claim 22 the rationale disclosed in the rejection of claim 2 is incorporated herein.

30. In regards to claim 23 the rationale disclosed in the rejection of claim 3 is incorporated herein.

31. In regards to claim 24 the rationale disclosed in the rejection of claim 4 is incorporated herein.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Peter-Anthony Pappas whose telephone number is 571-272-7646. The examiner can normally be reached on M-F 9:00am-5:30pm.

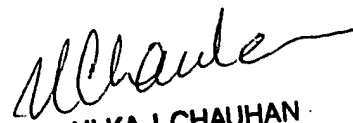
If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Ulka Chauhan can be reached on 571-272-7782. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

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PAP


ULKA J. CHAUHAN
PRIMARY EXAMINER